OPERATIONAL EXPERIENCE WITH X-RAY BEAM POSITION MONITORS IN ORBIT FEEDBACK AT THE ADVANCED PHOTON SOURCE

O. Singh and G. Decker

OPERATIONAL EXPERIENCE WITH XBPM IN ORBIT CONTROL

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OPERATIONAL EXPERIENCE WITH X-RAY BPM IN ORBIT CONTROL

- Motivation
- Upgrades
- Orbit Control Configuration
- Bending Magnet X-ray BPM
- Insertion Device X-ray BPM
- Summary and Future Plans

MOTIVATION

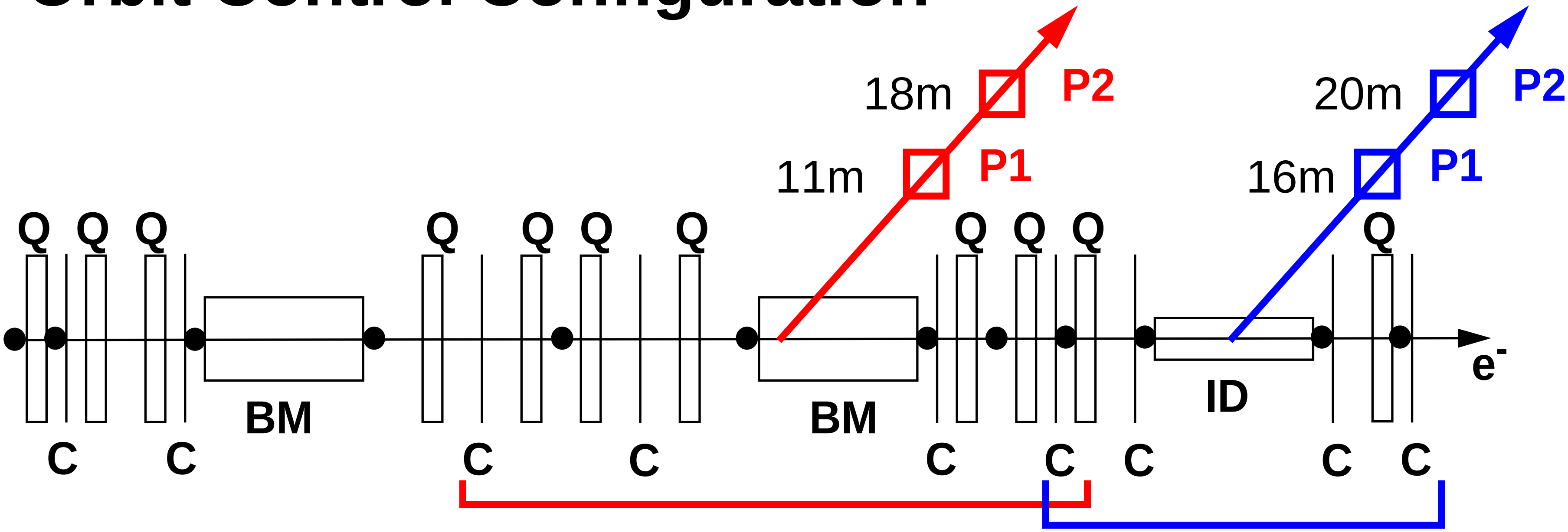
Why Use XBPM for Orbit Contol at APS ?

- XBPM can provide better quality beam position measurements - thermally insulated and vibration-dampened support structure;
    - Very small dependence on environmental temperature changes
    - Vibration displacement < 0.1 micron rms, ~ 1 - 50 Hz
- XBPMs are closer to the users, providing more realistic user's beam position information (11 to 20 meters from source point).
- XBPM provides increased angular measurement resolution - up to factor of 8 compared to RFBPM
- XBPMs can also be used to measure ID steering effects as gap varies

UPGRADES

- Upgrade XBPM data acquisition system - (*Frank Lenkszus - TOPB011*)
- Upgrade feedback/feedforward correction strategy - *(Glenn Decker WOPA003)*
    - DC Orbit and Real Time Feedback
    - Feedforward Correction - reduces ID steering effects to the electron orbit outside the ID
- Interface XBPM translation stages to EPICS -
    - to expedite blade alignments
    - to calibrate XBPMs electronics/cross-calibrate RFBPMs.
- Replace and/or repair radiation damaged motors and few faulty stages
- Eliminate background stray radiations on ID XBPMs - modify lattice

Orbit Control Configuration



Legend:

C: Corrector Magnet

●: RF Beam Position Monitor

X: X-ray Beam Position Monitor

Q: Quadrupole

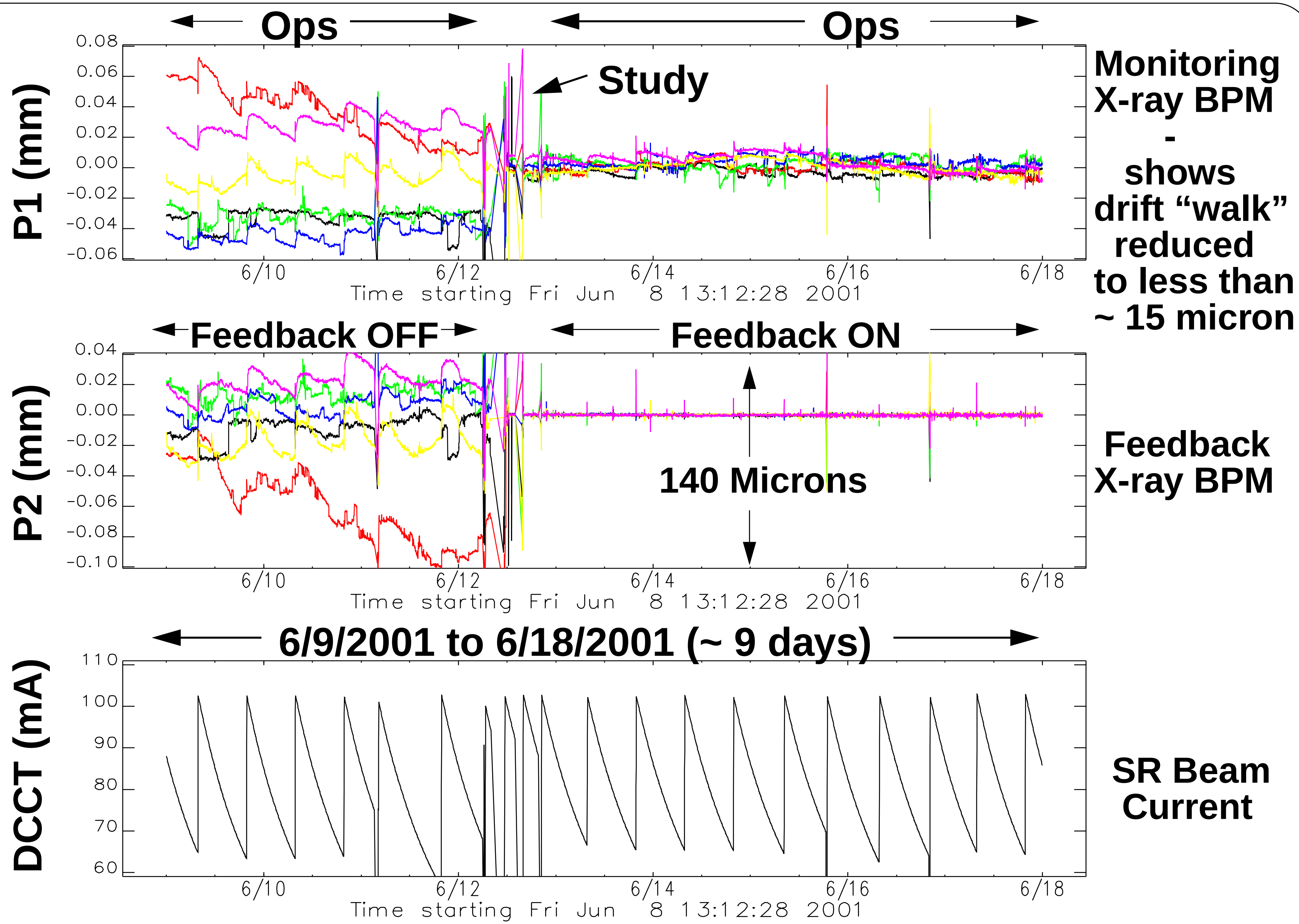
BM: Bending Magnet

ID: Insertion Device

Config.	BPMs	Correctors
Global	11 RF (all)	2
Local - 1	P1 or P2	4
Local - 2	P1 and P2	4

XBPM weight = 5; RFBPM weight = 1

BM X-ray BPM Orbit Feedback Results for 6 Beamlines



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Operational Experience with X-ray BPMs
PAC 2001, June 18-22, 2001, Chicago,IL
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Insertion Device X-ray BPMs

- ID XBPM measurements at a given ID are severely affected with gap change -

1. <u>Background stray radiation</u>

2. <u>ID steering effects</u>

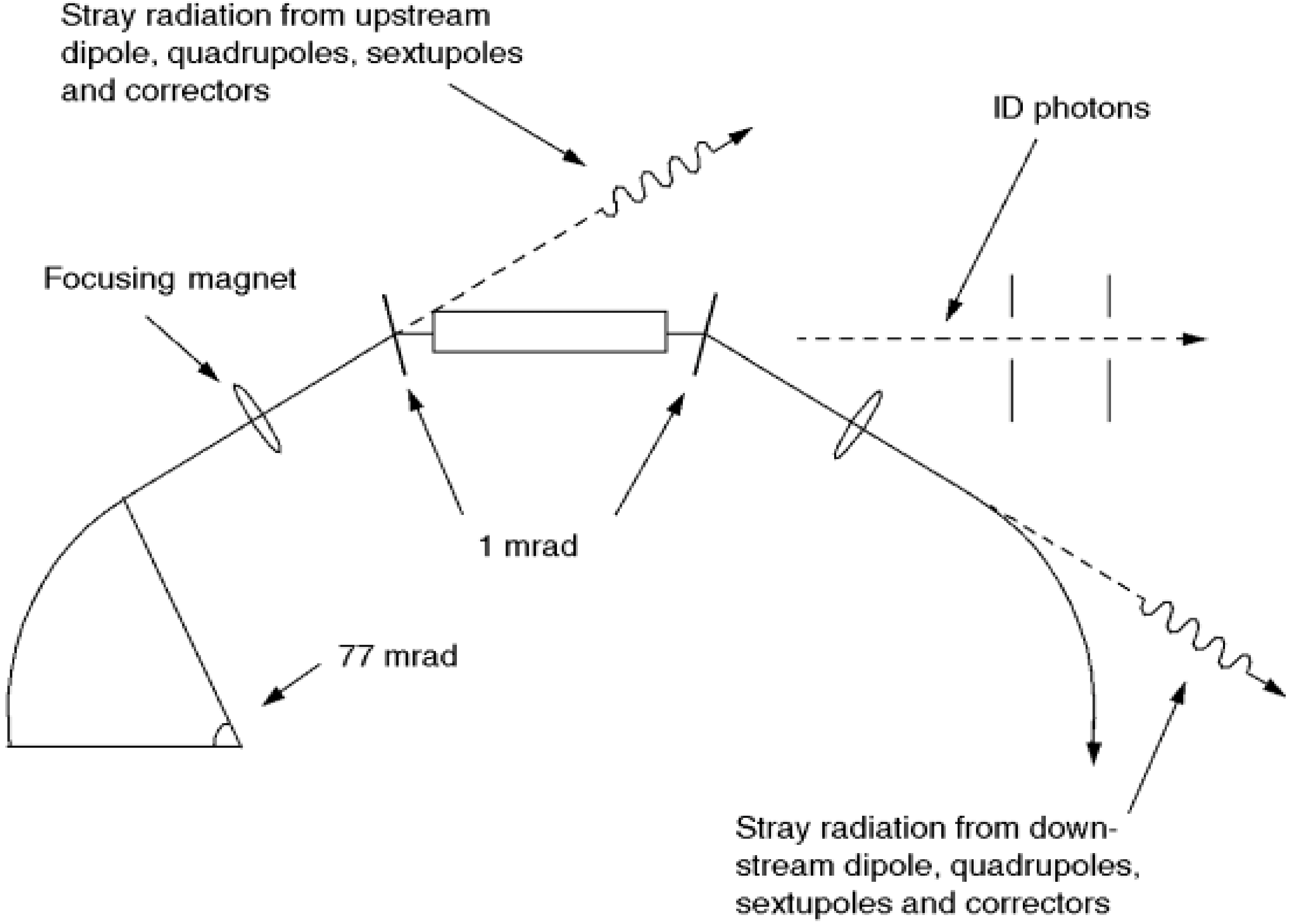
   - Causes distortion to the electron orbit <u>external to the ID</u>
   - Causes distortion to the electron orbit <u>internal to the ID</u>

Insertion Device X-ray BPMs

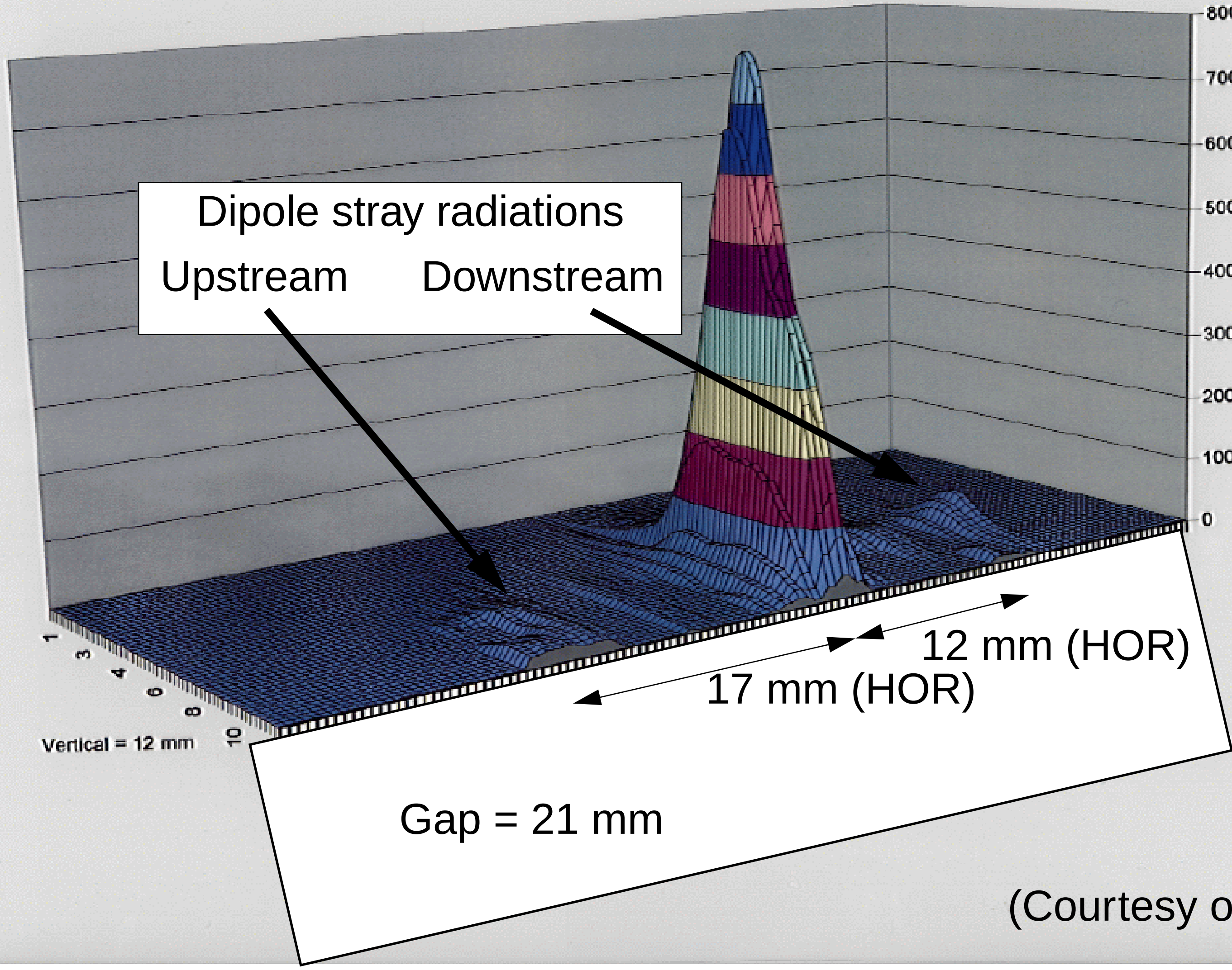
Strategy to reduce background and ID steering effects:

1. Background stray radiation:
   - Lattice modification eliminates this radiation
   - But it adds 1-mrad correction-generated radiation whose effects are reduced by Background subtraction procedure
2. ID steering effects on the electron orbit outside ID are reduced by implementing feedforward (FF) correction by using 2 correctors
3. ID steering effects on the electron orbit inside ID and the effects of variation in blade response can be lumped into XBPM offset

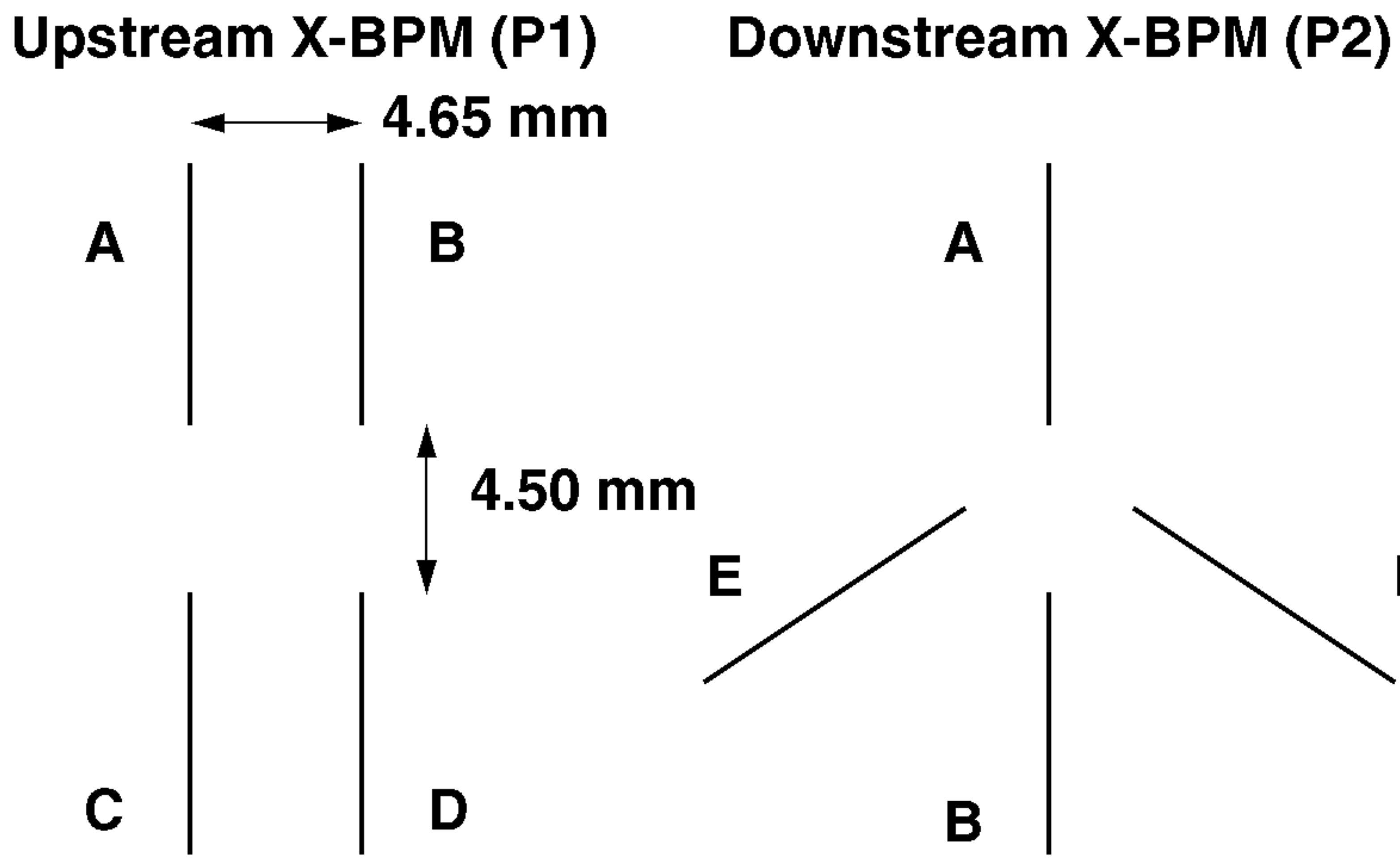
Reducing Background Radiation by Lattice modification



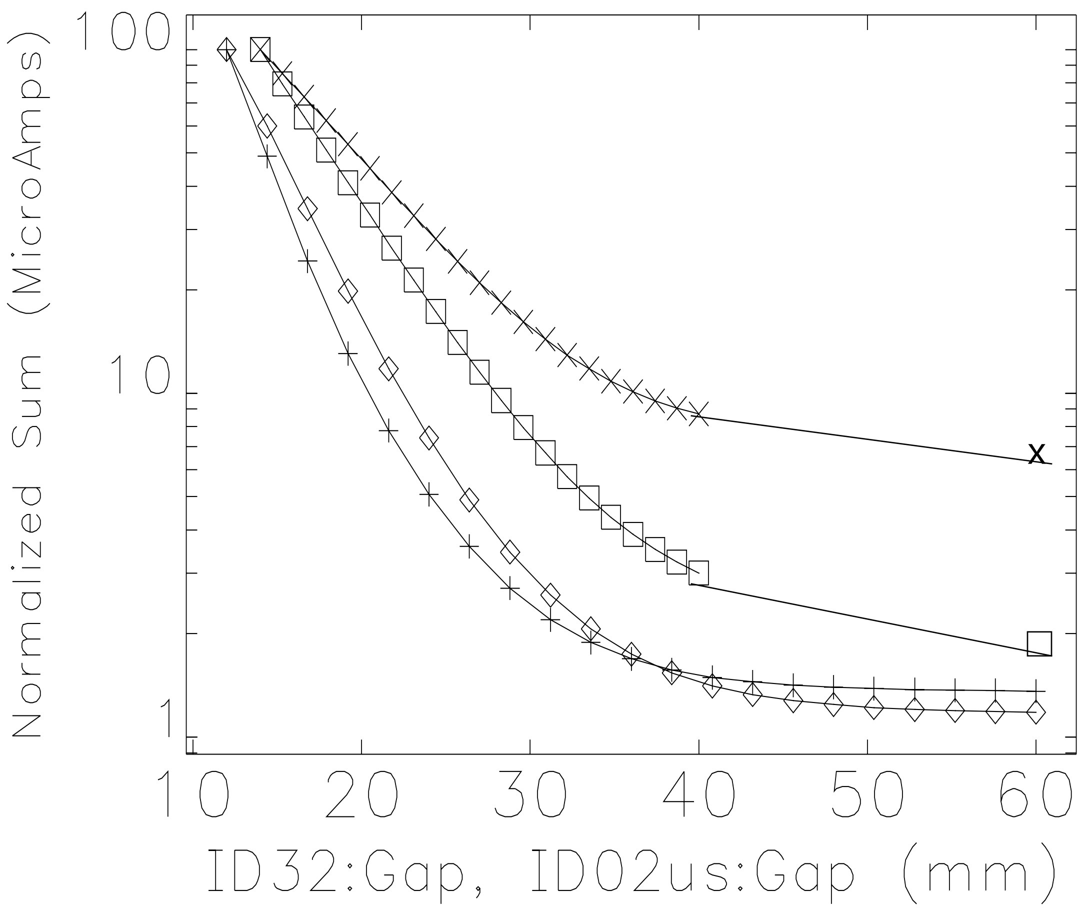
ID 34 and background stray radiations after Lattice Modification



(Courtesy of D. Shu)


Upstream X-BPM (P1)
Downstream X-BPM (P2)
4.65 mm
A
B
A
4.50 mm
E
F
C
D
B

Stray Radiation Reduction due to lattice Modification for ID 02 and ID32



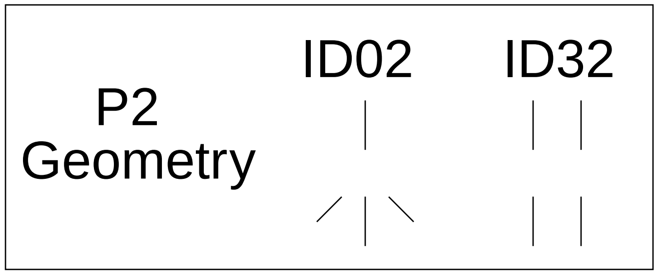
Without lattice modification sum signals are between 15 to 30 microAmps with gap open to 60 mm.

S02-ID P2 (standard P2 geometry)

S02-ID P1

S32-ID P2 (P1 geometry)

S32-ID P1



BACKGROUND SUBTRACTION

Details

ID33 Xray Bpms

		Ave Data	Normalized	Adjusted	Units	Offset
P1	A	6.907	6.889	5.982	microA	0.907
	B	12.197	12.165	11.369	microA	0.796
	C	10.205	10.179	9.717	microA	0.462
	D	7.387	7.368	7.050	microA	0.318
P2	A	30.435	30.356	30.313	microA	0.043
	B	36.010	35.917	35.917	microA	0.000
	E	18.319	18.271	9.586	microA	8.685
	F	30.634	30.555	11.975	microA	18.580

	Num to Ave	Normalization Factor
Remote	15	0.997

Normalization Factor = 100/(Beam Current)

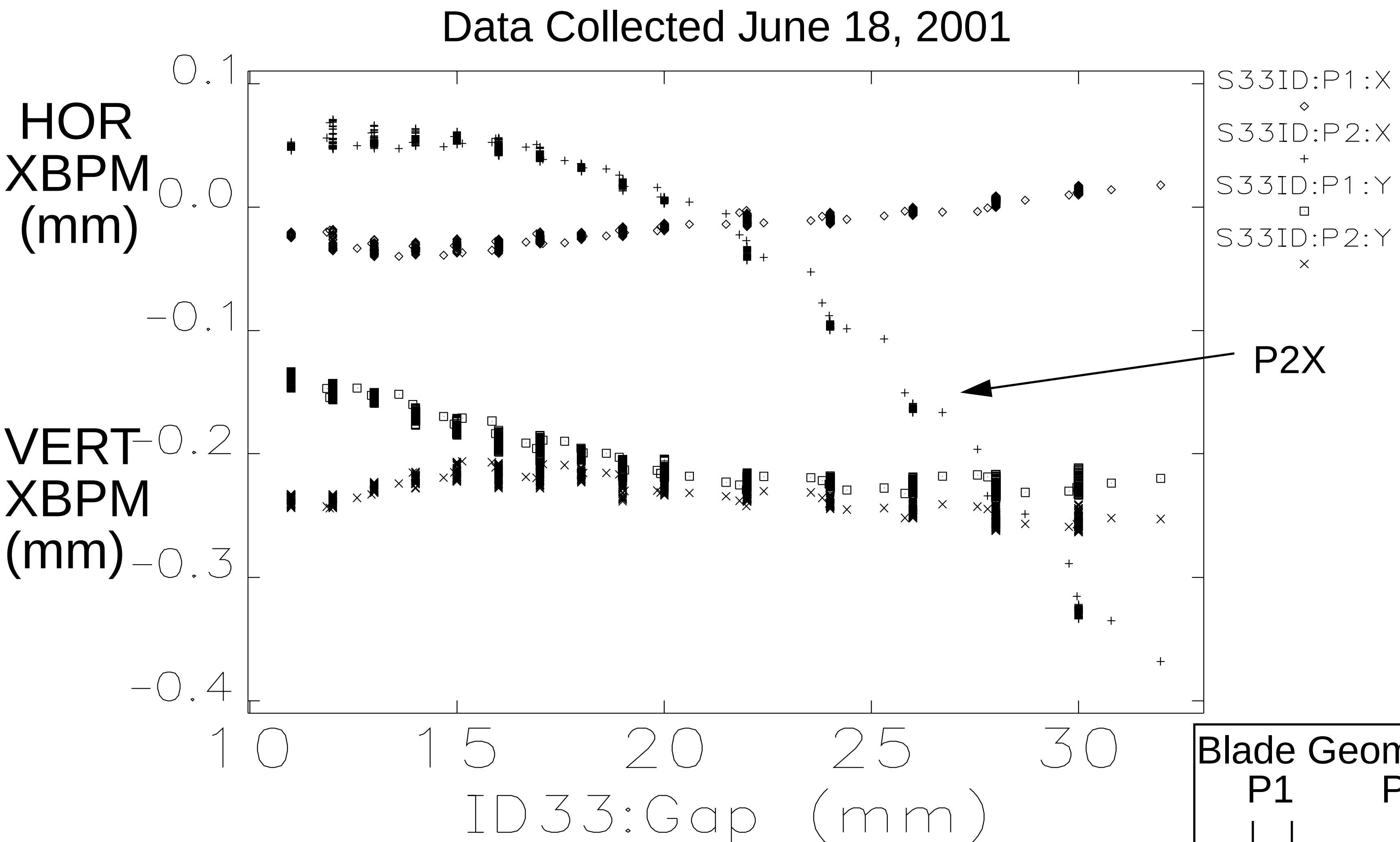
Normalized = (Ave Data) * Normalization Factor

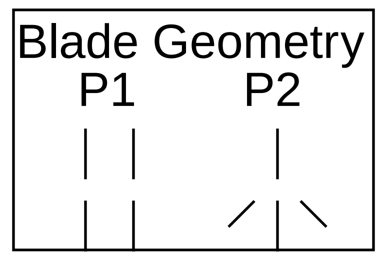
Adjusted = Normalized - Offset

$$\text{Adjusted} = (\text{Raw} - \text{Offset})_{\text{normalized}}$$

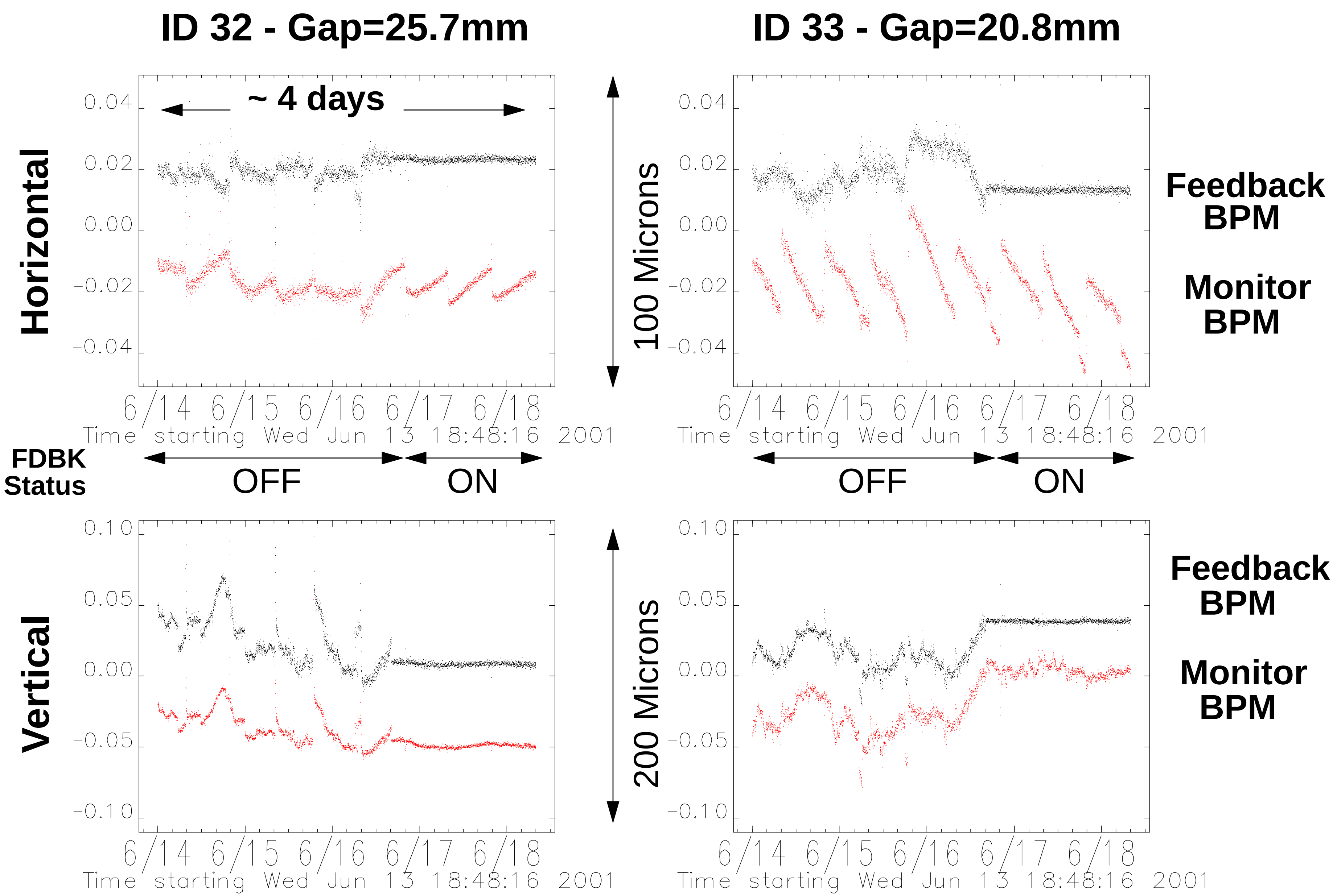
$$\text{Position} = (\text{Delta}/\text{Sum})_{\text{adjusted}}$$

ID 33 Steering Effects due to Gap Change





Fixed Gap Results with ID X-ray BPM Feedback ON for two Beamlines



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STATUS

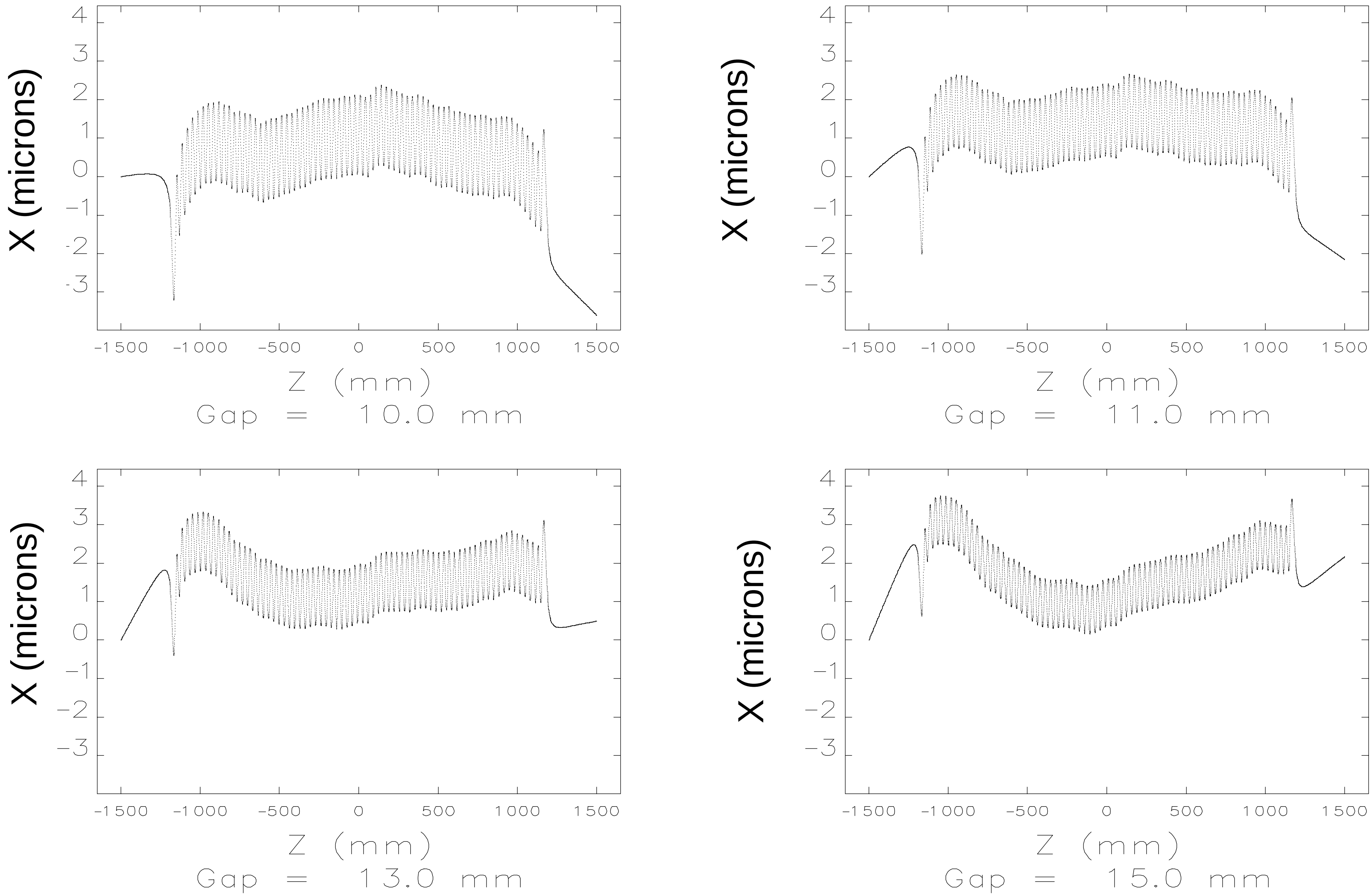
- XBPM data acquisition installation completed for 14 sectors - others to be done by October, 2001.
- BM XBPMs orbit feedback commissioned for 8 beamlines
- Lattice modification completed for 9 out 22 IDs.
- ID XBPM orbit feedback under test at a fixed gap

PLANS

- Implement feedforward correction for all IDs
- Measure ID XBPM based “offset” as gap changes
- Collaborate with users to determine orbit stabilty as gap changes
- Increase correction bandwidth for DC orbit feedback to > 1 Hz
- Upgrade real time feedback system to include XBPMs

Variation of Particle Trajectory Through Insertion Device vs Gap

(Derived from Second Field Integral of Magnetic Measurement Data)



Variation of RF bpm's while cycling 33ID from 15 to 30 mm gap- FF on vs off